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September 29, 2004
BVY 04-103

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Subject: **Vermont Yankee Nuclear Power Station**
License No. DPR-28, Docket No. 50-271
Reportable Occurrence No. LER 2004-002-01

As defined by 10 CFR 20.2201(d), we are submitting the attached reportable occurrence is LER 2004-002-01. This document is a revision to LER 2004-002-00 that provides the results of the special nuclear material inventory discrepancy discovered on April 04, 2004.

Sincerely,

ENTERGY NUCLEAR OPERATIONS, INC.
VERMONT YANKEE

Kevin Bronson
General Manager

cc: USNRC Region I Administrator
USNRC Resident Inspector - VYNPS
USNRC Project Manager - VYNPS
Vermont Department of Public Service

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NRC FORM 366 (6-2004) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES: 06/30/2007

Estimated burden per response to comply with this mandatory collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

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4. TITLE
Special Nuclear Material Inventory Location Discrepancy

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV. NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
									N/A	05000
04	20	2004	2004 -	002 -	01	09	29	2004	FACILITY NAME N/A	DOCKET NUMBER 05000

9. OPERATING MODE
N

10. POWER LEVEL
0

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*

☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
☒ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
☐ 20.2203(a)(2)(vi)	☐ 50.73(A)(2)(I)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER *(Include Area Code)*
Kevin Bronson, General Manager of Plant Operations	(802) 257-7711

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
N/A				N	N/A				N

14. SUPPLEMENTAL REPORT EXPECTED
☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

16. ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced type written lines)*

On 04/20/04, with the reactor shutdown for a refuel outage, an inventory of Special Nuclear Material (SNM) in the Spent Fuel Pool (SFP) revealed that two fuel rod pieces were not in the designated storage location. This condition was reported to the NRC on 04/21/04 pursuant to 10 CFR 50.72 (b)(2)(xi) as NRC Event Number 40694 for a news release, amended on 05/19/04 to address additional reporting regulations. The two fuel rod pieces were the product of a fuel reconstitution performed in 1979 due to Crud Induced Localized Corrosion (CILC) fuel rod failures identified at Vermont Yankee and elsewhere within the nuclear industry. An investigation team was formed to complete a root cause analysis of the event and to search for the fuel rod pieces. The investigation was accomplished primarily by completing an inspection of the SFP, document reviews, interviews with VY employees (past and present) and interviews with contractors that had been associated with SFP activities and radioactive waste operations at Vermont Yankee. On 07/13/04 the two fuel rod pieces were located in the SFP on top of the channel rack in a cylindrical liner specifically designed by General Electric for storing fuel rod pieces. On 07/13/04, the NRC was notified of this development in the investigation, and was documented as NRC Event Number 40867.

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17. NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)*

DESCRIPTION:

On 04/20/04, with the reactor shutdown for a refuel outage, an inventory of Special Nuclear Material (SNM) in the Spent Fuel Pool (SFP) revealed that two fuel rod pieces, approximately 0.493 inches in diameter by approximately 9 inches and 17.75 inches in length were not in their designated storage location. This event was initially reported as NRC Event Number 40694 pursuant to 10 CFR 50.72 (b)(2)(xi) on 04/21/04 in connection with a planned press release. An update to this notification was completed on 05/19/04 pursuant to 10 CFR 20.2201(a)(1)(ii), for "missing radioactive material" and under 10 CFR 74.11 for "lost SNM".

The two fuel rod pieces were the result of a fuel inspection, sipping, and reconstitution campaign that was performed in 1979 due to Crud Induced Localized Corrosion (CILC) fuel rod failures identified at Vermont Yankee (VY) and elsewhere within the nuclear industry. The two fuel rod pieces were believed to have been placed in narrow pipes that are an integral part of a larger stainless steel container and stored at the bottom of the SFP that is approximately 40 feet in depth. This container was only designed for storing the fuel rod pieces in the SFP and did not have the necessary shielding to allow for safe removal from the underwater environment.

The Special Nuclear Material Investigation Team (SNMIT) was formed to complete a root cause analysis of the event and to search for the two fuel rod pieces. The investigation was accomplished primarily by completing an inspection of the SFP, document reviews, interviews with VY employees (past and present) and interviews with contractors who have been associated with SFP activities and radioactive waste operations.

On 07/08/04, a forty-five inch by five inch, aluminum cylinder (liner) with a screw cap on one end and a one and a half inch hex nut on the opposite end was identified as potentially containing the two fuel rod pieces. This item was purchased from GE Vallecitos Nuclear Center in Pleasanton, CA and received at VY on 08/07/79. A review of the recently generated SFP video tapes established the location of the liner, situated horizontally on top of the fuel channel storage rack against the south wall of the SFP. A recovery plan was developed and on 07/13/04 the liner was opened and inspected, revealing the two fuel rod pieces. Verification measurements were performed and documented with underwater video equipment. To provide assurance that the fuel rod pieces found in the liner were those in question, GE Vallecitos Nuclear Center was contacted to determine if any fuel rod pieces, previously sent to them for examination had been returned. The response to this inquiry stated that; due to the destructive nature of post irradiation examination, GE Vallecitos Nuclear Center does not return spent fuel received for examination to the utilities. After examination, spent nuclear fuel is stored on site at their facility until disposal. Additionally, it should be noted that the measured radiation levels of the liner's exterior and the fuel rod pieces is in agreement with the calculated dose rates. On 07/13/04, the NRC was notified that the two fuel rod pieces had been located. This notification was listed as NRC Event Number 40867.

REGULATORY REPORTING REQUIREMENTS OF 10 CFR 20.2201:

10 CFR 20.2201(b) requires a written report within 30 days after an initial verbal notification is performed in accordance with 10 CFR 20.2201(a)(1)(ii), for the occurrence of any lost, stolen, or missing licensed material in a quantity 10 times greater than the quantity specified in Appendix C to Part 20. The initial written report (LER 2004-002-00) was submitted on 06/17/04. This report is a revision to the initial written report to communicate the results of the SNM investigation pursuant to 10 CFR 20.2201(d). The following topics listed below that were previously required to be addressed by 10 CFR 20.2201(b), have been addressed within this report.

(i) A description of the licensed material involved, including kind, quantity, and chemical and physical form; and

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(ii) A description of the circumstances under which the loss or theft occurred; and

(iii) A statement of disposition, or probable disposition, of the licensed material involved; and

(iv) Exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible total effective dose equivalent to persons in unrestricted areas; and

(v) Actions that have been taken, or will be taken, to recover the material; and

(vi) Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed material.

Topic (i): A description of the licensed material involved, including kind, quantity, and chemical and physical form.

During the SNM investigation, an accurate measurement was made of the remaining sections of the two fuel rods that were the source of the two pieces. It was subsequently determined that the fuel rod piece from location D-2, in fuel assembly LJ3915, was approximately 17.75 inches in length, and the fuel rod piece from location D-2, in fuel assembly LJ3949, was approximately 9 inches in length. Table 1 contains a detailed physical description and Table 2 contains the isotopic inventory of the fuel rod pieces.

Topic (ii): A description of the circumstances under which the loss or theft occurred.

No loss or theft of radioactive material occurred. The initial report (LER 2004-002-00) was made as a result of an SNM inventory completed on 04/20/04. On 07/13/04, because of actions taken by the SNMIT, the two fuel rods were found in the SFP, inside forty-five inch by five inch, aluminum cylinder (liner) on top of the fuel channel storage rack against the south wall in the SFP.

Topic (iii): A statement of disposition, or probable disposition, of the licensed material involved.

On 07/13/04 the location of the two fuel rod pieces was positively identified to be in the SFP and have existed there since removal from the original fuel bundles.

On 08/07/79, a forty-five inch by five inch, aluminum cylinder (liner) with a screw cap on one end and a one and a half inch hex nut on the opposite end was purchased and received by VY from General Electric (GE) Vallecitos Nuclear Center in Pleasanton, CA. This container was identified by the SNMIT as potentially containing the two fuel rod pieces. A review of the SFP video tapes established the location of the liner, situated on top of the back side of the fuel channel storage rack against the south wall inside the SFP.

On 07/13/04, a curb mounted hanger (termed the Canister Support Fixture (CSF)), specifically designed and fabricated for the GE liner was installed on the south side of the SFP between the two Fuel Preparation Machines, PM-1 and PM-2. The CSF was designed to hold the liner and provide an integral tamper-evident seal. Following installation of the CSF, the liner was moved to the CSF, the liner's cover was removed, and a camera examination inside confirmed that the liner contained the two fuel rod pieces. On 07/14/04, after the verification of the liner's contents was completed and documented, the liner's cover was re-installed and secured with a tamper proof seal. Video tapes of these evolutions were made to document verification of the fuel rod pieces and the method by which the liner was secured to the south wall of the SFP.

Topic (iv): Exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible total effective dose equivalent to persons in unrestricted areas.

No exposure to radiation occurred, or could have occurred to the public since the two fuel rod pieces did not leave the SFP. The total effective dose equivalent received by personnel in unrestricted areas because of this event was zero. Table 3 provides the estimated dose rates that could have been encountered if the unshielded fuel rod pieces were handled in air.

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Topic (v): Actions that have been taken, or will be taken, to recover the material.

The location of the two fuel rods has been confirmed as previously described, documented and entered into the VY SNM Inventory and Control processes and the Corrective Actions Program. No further recovery actions are necessary.

The SNMIT conducted interviews with 65 personnel consisting of VY employees (past and present) and contractors who have been associated with SFP and radioactive waste operations at Vermont Yankee.

The SFP inspection was performed with pole-mounted and robotic crawler-mounted cameras that searched accessible areas around the spent fuel storage racks as well as in empty fuel racks, other containers and storage areas. The following SFP inspections were completed by the team:

1. The container and integral piping where the two fuel rod pieces were believed to be stored.
2. Open spaces in the SFP.
3. Containers hanging on the wall that could contain the fuel rod pieces.
4. Accessible areas under the racks.
5. Accessible areas in between the fuel storage racks.
6. On top of the fuel assemblies.
7. All open cell locations that have not been used in the past two years.
8. Four fuel assemblies directly associated with the 1979 fuel inspection, sipping, reconstitution and replacement campaign (LJ3915, LJ3912, LJ3949 and LJ3891).
9. One additional fuel assembly (LJ3892) with one fuel rod that had separated into four pieces (3 pieces shipped to GE Vallecitos Nuclear Center; one remains in the fuel assembly).
10. Two fuel storage assemblies were inspected for verification of fuel rods and void spaces.
11. One forty-five inch by five inch, aluminum cylinder (liner) with a screw cap on one end and a one and a half inch hex nut on the opposite ends purchased from GE Vallecitos Nuclear Center for fuel rod piece storage.
12. All fuel assembly serial numbers were verified.

An extent of condition assessment was conducted for this event as part of the event investigation. This review included the physical search of the SFP as well as a thorough review of SNM, radiological waste and other related documents to ensure accountability of full and partial length rods.

Topic (vi): Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed material.

No loss or theft of radioactive material occurred. The root cause investigation is complete. The team of investigators completed a detailed physical inspection of the SFP, document reviews and personnel interviews. Corrective actions formulated by the SNMIT to prevent recurrence of this event are complete.

An independent assessment to identify areas for improvement to current processes for controlling SNM has been performed by the Entergy Nuclear Northeast Corporate Assessment group and incorporated into the VY Corrective Action Program. Corrective actions have been developed to ensure that this event will not recur.

All actions taken to prevent recurrence of this event are listed in the Corrective Actions section of this LER, including revisions to procedures currently in place. No new procedures have been developed because of this event.

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CAUSES:

Two root causes and four contributing causes were identified by the SNMIT.

Root Causes

1. The SNM accounting devices required by the "Special Nuclear Material Inventory and Accountability Procedure" were not properly maintained.
2. The "Special Nuclear Material Inventory and Accountability Procedure" did not provide guidance for control of fuel pieces of SNM versus whole fuel assemblies.

Contributing Causes

1. The ownership, oversight, self-assessments and a questioning attitude with regard to SNM accountability were found to be insufficient.
2. The knowledge of where the two fuel rod pieces were located was displaced during the transfer of SNM Accountant responsibilities as employees moved to new positions within VY or left the company. No specific SNM Accountant training had been provided other than on-the-job turnover.
3. The inconsistent use of written and verbal terms, (e.g., "liner" versus "bucket") when referring to the fuel rod container that held the two fuel rod pieces, created errors in SNM records and documentation.
4. VY failed to use the 11/16/00 Millstone event as an opportunity to verify its own fuel rod piece inventory. Although performing this search in 2000/2001 would not have prevented the mis-identification of the container where the fuel rod pieces were stored, it may have allowed the situation to have been detected and corrected three years earlier.

ASSESSMENT OF SAFETY CONSEQUENCES:

The health and safety of the public and station personnel were not at risk as a result of this issue. The investigation concluded that the spent fuel rod pieces remained in the SFP at all times.

CORRECTIVE ACTIONS:

Immediate Actions:

1. Contacted the appropriate management personnel, notified the NRC Resident Inspector and notified the NRC Operations Center pursuant to 10 CFR 50.72(b)(2)(xi) for a news release, recorded as USNRC Event Number 40694.
2. Entered this event into the station's corrective actions process, and established a SNM Investigation Team consisting of plant staff, Entergy shared resources and external consultants.

Investigation Team Actions:

1. Completed an inventory of SNM located in the SFP. This effort consisted of the following:
   a. A check of every spent fuel assembly serial number against the documented location in the SFP racks. No discrepancies in the SNM records were noted.
   b. A verification of the Local Power Range Monitor (LPRM) detectors documented to be stored in the SFP. No discrepancies noted.

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c. A verification that the remaining portions of partial fuel rods were in their documeted locations. No discrepancies noted.

2. Performed SFP inspections as described in the response to Topic (v).
3. Verified that all spent fuel assemblies stored in the SFP are in their correct locations.
4. Performed a methodical review of pertinent documents to gather information used to create timelines of significant events, to identify the current location of the two fuel rod pieces and to analyze potential exit scenarios from the plant.
5. Conducted interviews with key personnel who were involved with SNM control. Information obtained from the interviews was successfully used to identify the location of the two fuel rod pieces.
6. Provided a preliminary Licensee Event Report [LER 2004-002-00] on 06/17/04 to communicate the status of the investigation, describe the missing radioactive material, provide a public safety assessment and to comply with the reporting requirements of 10 CFR 20.2201(b).

Interim Corrective Actions:

1. SNM accountability forms have been revised to be in compliance with station procedural requirements of OP 0400, "Special Nuclear Material Inventory and Accountability Procedure".
2. Re-inventoried SNM in the skimmer pump room, LPRM Box, dunking chambers on the refuel floor, and placed tamper evident tape on SNM containers.
3. A Corporate Assessment of VY's SNM Program was performed.
4. Station procedures were revised to include the appropriate regulatory reporting requirements for a Loss, Theft or Attempted Theft of SNM.
5. Reactor Engineering oversight and assessment of the SNM Process has been increased as demonstrated by the following programmatic and process improvements;
   a. The SNM inventory was reviewed.
   b. A detailed video taped record of fuel assembly serial number verification of the SFP was completed.
   c. A re-inventory of non-fuel inventory that was accessible was performed with an independent peer check of both the fuel and non fuel inventories.
   d. SNM inventory that could be made tamper evident was done correctly with new standards that meet the current regulation.
   e. The two fuel pieces stored in a GE liner were inspected, made tamper evident, and stored in an engineered canister holder so that when performing future SNM physical inventories, the fuel pieces will now be inventoried by verifying the container is sealed and the tamper device is intact.
   f. Records for the two fuel pieces were updated and verified.
   g. RE Management performed discussions and coaching with the RE Department that covered the causes of the missing fuel pieces that included current regulatory requirements and event precursors.

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h. A Project Manager was assigned to manage the SNM corrective actions.

i. Future Self-assessments of the SNM program have been scheduled and entered into the Corrective Actions Program.

j. A Management observation for the 2005 annual SNM inventory has been scheduled and entered into the Corrective Actions Program.

Long Term Corrective Actions

1. Evaluate SFP control and ownership regarding roles and responsibilities, control of contents, interface requirements, performance of assessments, SFP configuration control, expectations for the use of drawings for determining SFP contents and provide recommendations to the GMPO.
2. GMPO to determine the final division of roles and responsibilities for the SFP upon completion of Long Term Corrective Action number 1.
3. Strengthen the Quality Assurance (QA) oversight/assessment of the SNM Process and provide a schedule for periodic SNM Assessments.
4. Establish a multi-disciplined team to evaluate and recommend improvements to the SNM administrative controls.
5. Develop a case study from the SNM event for use in management training to emphasize procedural compliance and personnel accountability.
6. Revise OP 0400, "Special Nuclear Material Inventory and Accountability Procedure" for definitions and requirements for the use of locks as a tamper-evident seal.
7. Evaluate the need for a formal turnover process of important information for critical positions and job functions when a person leaves VY.
8. Develop a training plan, including qualification cards for Reactor Engineers that includes SNM responsibilities.
9. Establish a trained and qualified back-up SNM Accountant.
10. Revise OP 0400, "Special Nuclear Material Inventory and Accountability Procedure" to include Dry Fuel Storage SNM accounting requirements.
11. Develop an Operating Experience (OE) training module for applicable training programs that will cover missed opportunities and lessons learned for the SNM event at VY.
12. Revise OP 0400, "Special Nuclear Material Inventory and Accountability Procedure" for the interm changes prior to perform annual SNM inventory.
13. Evaluate physical SNM Inventory methods and practices, including piece count.
14. Review accounting methods for individual fuel rods and fuel pellets.

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SUPPLEMENTAL CORRECTIVE ACTIONS

The corrective actions listed below are those that are not directly related to, or created as a result of a particular cause of the event. These actions were developed by the SNMIT from observations noted during the investigation and analysis process that presented improvement opportunities for various programs, procedures and processes.

1. A change was issued to procedure OP 0044, "Volume Reduction, Packaging and Shipping of Irradiated Hardware" deleting the step that allows other miscellaneous hardware to be removed from the SFP.
2. A change was issued to procedure OP 1100, "Refuel Platform Operation", requiring the Technical Support Manager's approval prior to the moving items in the SFP or removing items from the SFP.
3. Difficult to locate RE records, combined in aggregate storage that are similar to SNM records from the same time period have been reviewed for accuracy and completeness.
4. A plan was developed involving the use of a multidiscipline team to address the Corporate SNM Assessment recommendations.
5. SNM related records have been electronically indexed to meet the easily retrievable retrievable requirements.
6. Revise DP 0545, "Fuel Pool Storage Requirements" to reflect SFP configuration control, including items that are exempt from Radiation Protectection Department control.
7. Produce a Benchmarking Report for SNM processes.
8. Conduct an Effectiveness Review of the Corrective Action Plan.
9. Present the results of the Effectiveness Review to the Corrective Actions Review Board (CARB).
10. Review the characterization and labeling of items in the SFP.
11. Review OP 0044, "Volume Reduction, Packaging and Shipping of Irradiated Hardware" for adequacy of controls for SNM during SFP clean-up efforts. Include a requirement within the procedure to ensure that the contents of closed containers are verified before disposal as part of a fuel pool clean-up.

ADDITIONAL INFORMATION:

No similar events were identified to have occurred at Vermont Yankee.

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Table 1: Spent Fuel Rod Description

Type of Special Nuclear Material	Spent Fuel Rods, GE Bundle		
Material	Uranium Dioxide initially enriched to 3.01 percent, encased in Zircalloy 2 cladding		
Physical Form	Solid		
	Fuel Rod 1 (LJ3949)	**Fuel Rod 2 (LJ3915)**	**Total**
Length of Spent Fuel Rods	9 inches	17.75 inches	N/A
Spent Fuel Rod Diameter	0.493 inches	0.493 inches	N/A
Effective Full Power Days	855	730	N/A
Exposure MWD/MT	20064	17133	N/A
Weight of Special Nuclear Material	204 grams	405 grams	609 grams

Note: Weights and activities presented in this table have been corrected for the year 2004.

Table 2: Spent Fuel Rod Isotopic Inventory

Nuclide	17.75" Fuel Rod Piece		9" Fuel Rod Piece		Total	
	Mass (grams)	Activity (Curies)	Mass (grams)	Activity (Curies)	Mass (grams)	Activity (Curies)
U-235	5.278E+00	1.141E-05	2.676E+00	5.785E-06	7.954E+00	1.720E-05
U-238	3.353E+02	1.128E-04	1.700E+02	5.719E-05	5.230E+02	1.700E-04
Pu-239	1.415E+00	8.798E-02	7.175E-01	4.461E-02	2.133E+00	1.326E-01
Pu-240	3.831E-01	8.734E-02	1.942E-01	4.429E-02	5.773E-01	1.316E-01
Pu-241	7.533E-02	7.764E+00	3.820E-02	3.937E+00	1.135E-01	1.171E+01
Pu-242	4.265E-02	1.629E-04	2.163E-02	8.260E-05	6.428E-02	2.455E-04
Am-241	1.773E-01	6.089E-01	8.990E-02	3.087E-01	2.672E-02	9.176E-01
Cm-242	4.604E-07	1.523E-03	2.334E-07	7.722E-04	6.938E-07	2.292E-03
Sr-90	5.890E-02	8.120E+00	2.986E-02	4.117E+00	8.876E-02	1.224E+01
Cs-137	1.230E-01	1.066E+01	6.237E-02	5.405E+00	1.854E-01	1.607E+01
Co-60	1.880E-05	2.131E-02	9.532E-06	1.081E-02	2.833E-05	3.212E-02
Ni-63	3.370E-04	1.911E-02	1.709E-04	9.690E-03	5.079E-04	2.880E-02
Ni-59	1.780E-03	1.440E-04	9.024E-04	7.301E-05	2.682E-03	2.170E-04
Nb-94	4.650E-05	8.709E-06	2.357E-05	4.414E-06	7.007E-05	1.312E-05
Tc-99	1.500E-01	2.530E-03	7.606E-02	1.283E-03	2.261E-01	3.813E-03
I-129	3.130E-02	5.534E-06	1.587E-02	2.806E-06	4.717E-02	8.340E-06

Notes:

1) Weights and activities presented in this table have been corrected for the year 2004.

2) The isotopic inventory for the 17.75 inch fuel rod piece was calculated by ORIGEN. Radionuclides and weights for the 9 inch have been derived by linear interpolation.

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Table 3: Spent Fuel Rod Estimated Dose Rate Summary - Unshielded

	17.75" Fuel Rod Piece (rad/hr in air)			9" Fuel Rod Piece (rad/hr in air)		
Years of Decay	Dose Rate On Contact	Dose Rate at 1 ft	Dose Rate at 3 ft	Dose Rate On Contact	Dose Rate at 1 ft	Dose Rate at 3 ft
0	3.52E+06	5.55E+04	7.12E+03	3.40E+06	3.24E+04	3.66E+03
1	1.12E+04	1.84E+02	2.37E+01	1.08E+04	1.07E+02	1.22E+01
2	5.48E+03	9.05E+01	1.17E+01	5.28E+03	5.30E+01	6.03E+00
4	3.25E+03	5.40E+01	6.98E+00	3.12E+03	3.16E+01	3.60E+00
10	1.60E+03	2.69E+01	3.49E+00	1.54E+03	1.59E+01	1.81E+00
15	1.28E+03	2.15E+01	2.79E+00	1.23E+03	1.27E+01	1.43E+00
20	1.10E+03	1.86E+01	2.41E+00	1.06E+03	1.09E+01	1.24E+00
25	9.65E+02	1.63E+01	2.11E+00	9.27E+02	9.59E+00	1.09E+00